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EXAMINER

D'ANIELLO, NICHOLAS P

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ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

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DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1-3, 5-8, 10-11 and 16 are rejected under 35 U.S.C. 103 (a) as being unpatentable over Lederich et al. (US Patent No. 4,415,375) in view of Zwicker et al. (US Patent No. 2,892,742) and Beall (US Patent No. 1,360,358).

Lederich et al. teach a method of machining a titanium alloy by first performing a "hydrogen charging step" where the work piece is heated in a hydrogen containing atmosphere during which the work piece absorbs the hydrogen. The titanium work piece is then formed in a die press (machined) and the hydrogen is removed by heating the work piece in a vacuum (hydrogen free atmosphere) (column 3 lines 28-67). Although not specifically taught, a cooling step would naturally flow in the process of Lederich et al. since the work piece would be exposed to a natural cooling as it is removed from the furnace and exposed to an ambient atmosphere. In any event, it would have been obvious to include a cooling step in the process of Lederich et al. because Zwicker et al. teach a process for improving the workability of titanium alloys using a similar hydrogen charging process where the hydrogen is later removed where the work piece is allowed to cool after the hydrogen charging step prior to the hydrogen removal

(column 2, *Example 1*). This claim differs from Lederich et al. in calling for metal-removing machining of the work piece because it is unclear whether metal is removed during the die pressing (i.e. machining) step of Lederich et al. However, it would have been obvious in the art to remove the excess metal from the work piece after the die pressing in the process of Lederich et al. as such is an art recognized technique for die-pressing a metallic material as exemplified in the teachings of Beall (page 1 lines 47-57).

Regarding claim 2, Lederich et al. teach that the hydrogen is typically removed by heating the formed part in a vacuum (column 3 lines 63-67).

Re claim 3, Lederich et al. teach that the hydrogen charging step is performed between 600°-760°C (873K-1033K) (column 3 lines 49-50).

Re claim 5, Lederich et al. teach that the hydrogen charging step (annealing time in hydrogen containing atmosphere) is performed for two hours prior to forming (column 4 lines 23-24).

Re claim 6, Lederich et al. is silent regarding a cooling step, however it would have been obvious to cool the work piece in a hydrogen containing atmosphere because Zwicker et al. teach that the work piece is heated in an oven containing hydrogen and allowed to cool in the same oven (column 2 lines 41-44).

Re claim 7, although Lederich et al. is silent regarding a quantitative value of the vacuum pressure it would have been obvious to use a vacuum pressure of least $2 \cdot 10^{-3}$ Pa because Zwicker et al. teach that the hydrogen is removed under a **high** vacuum (column 2 lines 46-48).

Re claim 8, Lederich et al. teach, in one example, that the hydrogen removal step is performed at 650°C (923K) (column 4 lines 33-36).

Re claims 10 and 11, Lederich et al. teach that the hydrogen content introduced into the alloy should be between 0.1 and 0.5 weight percent to improve the formability, above 0.2 weight percent preferably (column 3 lines 19-22).

Additionally, Zwicker et al. teach the hydrogen composition to be 0.505% after the hydrogen charging step (column 2 lines 41-44).

Re claim 16, Lederich et al. teach that this process is suitable for Ti-6Al-4V (column 3, lines 11-13).

3. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lederich et al. (US Patent No. 4,415,375), Beall (US Patent No. 1,360,358) and Zwicker et al. (US Patent No. 2,892,742) as applied to claim 1 above, and further in view of Smickley et al. (US Patent No. 4,505,764).

Lederich et al. in view of Zwicker et al. teach the method as presented in independent claim 1. Claim 4 differs from Lederich et al. and Zwicker et al. in calling for the hydrogen containing atmosphere to be under a pressure of approximately 5 kPa. However, it would have been obvious in the art to use a pressure of around 6.9 kPa because Smickley et al. teach a method of refining the microstructure of titanium by heating the work piece in a hydrogen containing atmosphere where the pressure is kept constant around 1 psi (which converts to roughly 6.9 kPa) (column 9, *Example 1*). Approximately 5 kPa is taken to read

on around 6.9 kPa. In any event, it would have been obvious to use a pressure of approximately 5 kPa because one in the art would have reasonably expected that substantially the same desired result would be achieved as this is close to the pressure (around 6.9 kPa) taught by Smickley et al.

4. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lederich et al. (US Patent No. 4,415,375), Beall (US Patent No. 1,360,358) and Zwicker et al. (US Patent No. 2,892,742) as applied to claim 1 above, and further in view of Garg et al. (US Patent No. 4,902,535).

Lederich et al. in view of Zwicker et al. teach the method as presented in independent claim 1. Claim 9 differs from Lederich et al. and Zwicker et al. in calling for the heating to be carried out inductively, whereas the references are silent on the mechanism of heating. However, it would have been obvious in the art to use an inductive furnace because Garg et al. teach a method for depositing coatings on titanium where the work piece is heated in an inductive graphite furnace which has hydrogen containing atmosphere (column 6, *Control 1*).

5. Claims 12-13 are rejected under 35 U.S.C. 103 (a) as being unpatentable over Lederich et al. (US Patent No. 4,415,375), Beall (US Patent No. 1,360,358) and Zwicker et al. (US Patent No. 2,892,742) as applied to claim 1 above, and further in view of Fisher et al. (US Patent No. 5,211,775).

Lederich et al. in view of Zwicker et al. teach the method as presented in independent claim 1. The claims 12-14 differ from Lederich et al. and Zwicker et al. in calling for a removal of the oxide layers using an etching process.

However, it would have been obvious in the art to remove the oxide layers of the titanium work piece prior to heating because Fisher et al. teach a method of removing oxide layers from titanium work pieces using an etching solution containing nitric acid (HNO_3) (column 2 line 66 – column 3 line 3) because oxygen enriched area form very hard surface layers which low ductility which cause deterioration of strength and other mechanical properties in titanium (column 1, lines 49-52).

6. Claim 14 is rejected under 35 U.S.C. 103 (a) as being unpatentable over Lederich et al. (US Patent No. 4,415,375), Beall (US Patent No. 1,360,358), Zwicker et al. (US Patent No. 2,892,742) and Fisher et al. (US Patent No. 5,211,775) as applied to claim 14 above, and further in view of Borowik (US Patent No. 2,974,021).

Lederich et al., Zwicker et al. and Fisher et al. teach the desirability to etch the oxide layer of a titanium work piece before improving the workability with a hydrogen charging step. Claim 15 differs from the references in calling for a composition comprising water, nitric acid, hydrofluoric acid and hydrogen peroxide for the etching solution. However it would have been obvious in the art to use a solution of hydrofluoric acid, hydrogen peroxide, nitric acid and water could be used because Borowik teach a solution for etching titanium containing

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10 parts by volume of 48% C.P. hydrofluoric acid, 60 parts by volume of U.S.P. 3% hydrogen peroxide, 10 parts by volume of commercial 69.3% nitric acid, and 30 parts by volume of distilled water (column 2, claim 1).

7. Claim 17-20 are rejected under 35 U.S.C. 103 (a) as being unpatentable over Lederich et al. (US Patent No. 4,415,375), Beall (US Patent No. 1,360,358) and Zwicker et al. (US Patent No. 2,892,742) as applied to claim 16 above, and further in view of Whang et al. (US Patent No. 4,512,826).

Lederich et al. in view of Zwicker et al. teach a method for machining Ti-6Al-4V as applied to claim 16. Claims 17 and 18 differ from Lederich et al. and Zwicker et al. in calling for a Ti-6Al-4V alloy with lanthanum in the content of 0.3 to 3.0 atomic percent. However, it would have been obvious in the art that lanthanum could be included because Whang et al. teach a method of precipitation hardening titanium alloys by adding a rare earth element (preferably lanthanum) in the amount of 0.1 to 2.0 atomic percent because it is relatively cheap (column 3 lines 37-43).

Regarding claims 19 and 20, while Whang et al. teach lanthanum to be the preferred rare earth element because it is relatively cheap, they also teach Ce (cerium) to be an acceptable alternative in the amount of 0.1 to 2.0 atomic percent (same section).

8. Claim 25 is rejected under 35 U.S.C. 103 (a) as being unpatentable over Lederich et al. (US Patent No. 4,415,375), Beall (US Patent No. 1,360,358), Zwicker et al. (US Patent No. 2,892,742) and Whang et al. (US Patent No. 4,512,826) as applied to claim 18 above, and further in view of Matsuo (US Publication No. 2002/0033717).

The references teach a method of machining titanium as applied to the claims above, claim 25 differs from the references in calling for more than 2 atomic percent lanthanum. However, it would have been obvious in the art to include additional lanthanum in the alloy (>2 atomic percent), because Matsuo teach titanium alloy compositions which may have more than 2 atomic percent elemental lanthanum (paragraph [0020]) which have excellent work hardening (paragraph [0022]).

9. Claims 21-24 is rejected under 35 U.S.C. 103 (a) as being unpatentable over Matsuo (US Publication No. 2002/0033717).

The following is a section from the MPEP 2144.05 concerning the obviousness of ranges: In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a *prima facie* case of obviousness exists. *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990); *In re Geisler*, 116 F.3d 1465, 1469-71, 43 USPQ2d 1362, 1365-66 (Fed. Cir. 1997) Similarly, a *prima facie* case of obviousness exists where the claimed ranges and prior art ranges do not overlap but are close enough that one skilled in the art would have expected them to have the same properties. *Titanium Metals Corp. of America v. Banner*, 778 F.2d

775, 227 USPQ 773 (Fed. Cir. 1985). Matsuo teach a titanium alloy (for producing a work piece made from a titanium based alloy) which has a variety of compositions extending from the general formula $Ti_{100-x-y}M1_xM2_y$ where M1 may be V and M2 may be Al, Zr and La such that x+y is 20 to 80 atomic percent, this composition includes alloys such as TiAl6V4 with 0.3 to 3 atomic percent elemental lanthanum with an additional alloying element such as Zr in an amount between 7 and 9.7 atomic percent (paragraph [0020]).

Regarding **claim 22**, Matsuo teaches a general titanium alloy composition where the lanthanum content may be above 2 atomic percent (paragraph [0038]).

As to **claim 23**, Matsuo teaches that $\alpha + \beta$ titanium alloys are common in alloys containing Al and/or V (paragraph [0005]).

In regard to **claim 24**, while not explicitly taught in Matsuo, as the compositions are patentably indistinguishable, the titanium alloy of Matsuo is reasonably expected to be able to be processed in such a manner that the lanthanum particles have a mean size larger than 2 microns.

10. Claim 26 is rejected under 35 U.S.C. 103 (a) as being unpatentable over Lederich et al. (US Patent No. 4,415,375) in view of Beall (US Patent No. 1,360,358) and Fisher et al. (US Patent No. 5,211,775).

Lederich et al. teach a method of machining a titanium alloy by first performing a "hydrogen charging step" where the work piece is heated in a hydrogen containing atmosphere during which the work piece absorbs the hydrogen.

Lederich et al. teach that the hydrogen charging step is performed between 600°-760°C (873K-1033K) (column 3 lines 49-50). The titanium work piece is then formed in a die press (machined) and the hydrogen is removed by heating the work piece in a vacuum (hydrogen free atmosphere) (column 3 lines 28-67).

Although not specifically taught, because no specific order of operation is required by the claim, a cooling step would naturally flow in the process of Lederich et al. since the work piece would be cooled before it is used in its prescribed application. This claim differs from Lederich et al. in calling for metal-removing machining of the work piece because it is unclear whether metal is removed during the die pressing (i.e. machining) step of Lederich et al. However, it would have been obvious in the art to remove the excess metal from the work piece after the die pressing in the process of Lederich et al. as such is an art recognized technique for die-pressing a metallic material as exemplified in the teachings of Beall (page 1 lines 47-57).

The claim also differs from the reference in calling for a removal of the oxide layers. However, it would have been obvious in the art to remove the oxide layers of the titanium work piece prior to heating because Fisher et al. teach a method of removing oxide layers from titanium work pieces using an etching solution containing nitric acid (HNO_3) (column 2 line 66 – column 3 line 3) because oxygen enriched area form very hard surface layers which low ductility which cause deterioration of strength and other mechanical properties in titanium (column 1, lines 49-52).

Allowable Subject Matter

11. Claim 15 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter: Although Borowik teaches a solution for etching titanium containing 10 parts by volume of 48% C.P. hydrofluoric acid, 60 parts by volume of U.S.P. 3% hydrogen peroxide, 10 parts by volume of commercial 69.3% nitric acid, and 30 parts by volume of distilled water (column 2, claim 1) this claim distinguishes over the prior art of record by defining the ratio of the components to differ substantially such that one of ordinary skill in the art would not consider the solution an obvious variant. More specifically, the composition in claim 15 requires a much larger concentration of nitric acid and much less hydrogen peroxide and hydrofluoric acid (see table below).

	Claim 15 (mL)	Borowik (parts)
Water	50	30
Hydrogen Peroxide	8.5	60
Nitric Acid	50	10
Hydrofluoric Acid	1.5	10
TOTAL	110	110

Response to Arguments

Applicant's arguments with respect to claim 21 have been considered but are moot in view of the new ground(s) of rejection.

Applicant's arguments in regard to independent claim 1 have been fully considered but they are not persuasive. The examiner respectfully disagrees with council's assertion that there is no reason to add a cooling step to process of Lederich et al. Although not specifically taught in the reference, as noted in the previous rejection, it would have been obvious that the formed part would be removed from the heated die and allowed to cool before being used in its given application. The process as claimed does not positively require a sequence of events and therefore the cooling step is seen as inherent because the workpiece will be cooled before it is employed for its application.

The examiner respectfully disagrees with applicant's statement on page 13 of the REMARKS stating that there is no die-pressing operation in Lederich et al. In column 4, lines 25-69 Lederich et al. disclose that disks were formed in a die (die pressing) at 860°C and then the hydrogen was removed in a vacuum at 650 °C (including another cooling step). The formed parts can be seen in figures 1 and 2 where the titanium has conformed to the die. However, as previously asserted in the rejection, these parts often require metal removing of the excess metal such as taught by Beall to conform to the required final part geometry. The term “superplastic forming” is a used to describe the state of the metal is in during the forming and although term “die-pressing” is not

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specifically taught in Lederich et al. the compression of metal in a die such as taught by Lederich et al. is the same process of Beall; however the metal is in a “superplastic” state.

The examiner respectfully disagrees with applicant's statement on page 14 of the REMARKS stating that it would not have been obvious to cool in the oven (containing hydrogen) in view of Zwicker et al. Zwicker et al. state that the sample is heated in hydrogen and allowed to cool in the same oven such that the hydrogen content is increased to 0.505%. Although it is not *specifically* taught that the hydrogen atmosphere is maintained during cooling it would have been obvious that the atmosphere should not be altered during cooling so that the hydrogen remains in the sample during cooling because the object of this heat treatment is to impart the sample with hydrogen to increase its formability.

The examiner respectfully disagrees with applicant's statement on page 14 of the REMARKS stating that it would not have been obvious to have a vacuum of at least a certain value. Although the references do not teach any particular value, the desirability to use a **high** vacuum is disclosed because this will aid in hydrogen removal. Although this is a relative term one skilled in the art would appreciate that this teaching would motivate one to use the high vacuum; at least $2 \cdot 10 \text{ Pa}^{-3}$ is not an exceptionally high vacuum which would be precluded.

Conclusion

No claim is allowed. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nicholas P. D'Aniello whose telephone number is (571)270-3635. The examiner can normally be reached on Monday through Thursday from 8am to 5pm (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jerry Lorengo can be reached on (571) 272-1233. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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